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PATENT
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COMMON RADIAL PLANE MOTOR COOLING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 60/435,326, filed on December 19, 2002.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to cooling a motor and, more specifically, to a method and apparatus for efficiently cooling a motor without mixing hot outlet gases with cool inlet gases.

[0003] Turbines, engines, and motors generate heat due to high-speed rotational motion. The generated heat may cause damage to a motor, for example, by severely burning the motor coil. Additionally, excess heat may damage the motor bearings. Thus, it is necessary that generated heat must be discharged.

[0004] In a typical motor, cooling air is moved through the motor or bearing to provide cooling. Typically, air is introduced in an axial direction and air exits in a radial direction. Axial introduction of air usually involves blowing hot air over the bearing, causing heating of the bearing. To protect the bearing, diverter plates may be used to isolate the bearing from heat. The hot air may be diverted around the bearing before exiting the motor as outlet air. However, the inlet air is introduced through the same region as the outlet air. This causes the hot inlet air to mix with the cooler outlet air. As heat from the hot inlet air is transferred to the cooler outlet air, the achieved temperature differential is

lessened. Consequently, the amount of heat actually removed from the inlet air is less than ideal.

[0005] As can be seen, there is a need for an improved apparatus and method for cooling a motor to provide for bearing isolation, efficient cooling, and avoiding mixing inlet air with outlet air.

SUMMARY OF THE INVENTION

[0006] In one aspect of the present invention, an apparatus for cooling a motor comprises a motor housing with an upstream side and a downstream side; a shaft; the shaft disposed within the motor housing; an inlet hole in the motor housing; an outlet hole in the motor housing; the inlet hole arranged in the same radial plane as the outlet hole; and an air guide plate; the air guide plate formed to channel air from the inlet hole, over an outer surface of the shaft, and radially outward through the outlet hole.

[0007] In an alternative aspect of the present invention, an apparatus for cooling a motor comprises a motor housing with an upstream side and a downstream side; a shaft; an inlet hole in the motor housing; an outlet hole in the motor housing; a rotor mounted on the shaft; the inlet hole arranged in the same radial plane as the outlet hole; and an air guide plate; the air guide plate formed to channel air from the inlet hole, over an outer surface of the shaft, and into the rotor.

[0008] In another aspect of the present invention, an apparatus for cooling a motor comprises a motor housing with an axis, an upstream side and a downstream side; a shaft having a cylindrical outer surface; a bearing housing supporting the shaft; a bearing seal on the downstream side of the bearing housing; a plurality of through inlet holes formed in the motor housing; each of the plurality of through inlet holes arranged in the same radial plane; a rotor mounted on the shaft; and a plurality of air guide plates; each of the air guide plates formed to channel air from each of the plurality of through inlet hole,

adjacent the bearing seal, over the outer cylindrical surface of the shaft, and into the rotor.

[0009] In yet another aspect of the present invention, an apparatus for cooling a motor comprises a motor housing with an upstream side and a downstream side; a shaft having a cylindrical outer surface; an impeller mounted on the shaft; a plurality of rotor fins projecting radially outward from the cylindrical outer surface of the shaft; a plurality of through inlet holes formed in the motor housing; a plurality of through outlet holes formed in the motor housing; each of the plurality of through outlet holes arranged in the same radial plane; and a plurality of air guide plates; each of the air guide plates formed to channel air radially inward from a through inlet hole, over the outer cylindrical surface of the shaft, into the plurality of rotor fins, and radially outward through a through outlet hole.

[0010] In a further aspect of the present invention, a motor comprises a die cast aluminum motor housing with an upstream side and a downstream side; an impeller on an aluminum shaft; the shaft coaxial with the motor housing; the shaft having a cylindrical outer surface; a bearing housing on the downstream side of the impeller; a bearing seal on the downstream side of the bearing housing; a plurality of rotor fins projecting radially outward from the cylindrical outer surface of the shaft; a plurality of through inlet holes formed in the motor housing; the plurality of through inlet holes arranged in the same radial plane; a plurality of through outlet holes formed in the motor housing; each of the plurality of through outlet holes arranged in the same radial plane; each of the plurality of through inlet holes arranged in the same radial plane as each of the plurality of through outlet holes; and a plurality of air guide plates; each of the air guide plates formed to channel air from each through inlet hole, over the outer cylindrical surface of the shaft, and into the plurality of rotor fins.

[0011] In a still further aspect of the present invention, a method for cooling a motor comprises providing a motor housing; providing a through inlet hole in the motor housing; providing a through outlet hole in the motor housing; directing air

radially inward through the through inlet hole, into the motor housing, and radially outward through the through outlet hole; wherein the through inlet hole and the through outlet hole are in the same radial plane; wherein the radial plane is perpendicular to the axis of the motor housing.

[0012] These and other aspects, objects, features and advantages of the present invention, are specifically set forth in, or will become apparent from, the following detailed description of a preferred embodiment of the invention when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Figure 1 is a cross-sectional view of an apparatus for cooling a motor within a motor housing, according to an embodiment of the present invention; and

[0014] Figure 2 is a perspective view of the exterior of the motor housing of Figure 1, according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The following detailed description is of the best currently contemplated modes of carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention, since the scope of the invention is best defined by the appended claims.

[0016] The invention is useful for turbines, engines, motors, and other similar apparatuses. Specifically, the invention is useful for cooling motors that generate heat from high rotational speeds. For illustrative purposes, the following description is of a motor, however, it is to be understood that other applications can be substituted for the motor, such as turbines, engines, heat exchangers and other similar apparatuses.

[0017] The present invention may protect the bearing from damage from excess heat generated at high rotational speeds and heat generated by the motor. Cooling air may be directed radially inward into a motor, deflected towards a bearing, across a shaft, and accelerated radially outward from the motor. The cooling air entering the motor may never mix with the warm air exiting the motor. Because the air may enter and exit the motor through a common radial plane, heat may be removed from the motor quickly and efficiently.

[0018] In more specifically describing the present invention, and as can be appreciated from Figure 1, the present invention provides a motor 10. The motor housing 72 may be composed of any suitable material, for example, die cast aluminum. The impeller 44 may be made of aluminum or any other suitable material. The impeller 44 may rotate on a shaft 22, which may also be made of aluminum or any other suitable material. The motor 10 may have an upstream side 46 and a downstream side 48. An axis 16 may be situated centrally within the motor 10. The shaft 22 may be coaxial with the motor housing 10. A bearing housing 92, houses lubricated bearings 94, which may be mounted around a cylindrical outer surface 98 of the shaft 22. The position of the bearing housing 92 may be adjacent to the downstream side 48 of the impeller 44. A bearing seal 84 may be situated downstream from the bearing housing 92, with an optional fluid channel 82 separating the bearing seal 84 from the bearing housing 92. A rotor 20 may include a plurality of rotor fins 24 that project radially outward from the rotor 20, away from the cylindrical outer surface 98 of the shaft 22. A plurality of through inlet holes 12 may be formed in the motor housing 10; optionally the inlet holes 12 may be situated in a common radial plane. Likewise, a through outlet hole 14 may be formed in the motor housing 10. The through inlet hole 12 may be arranged in the same radial plane 18 as the outlet hole 14. The radial plane 18 may be perpendicular to the axis 16. An air guide plate 26 may be situated between the inlet hole 12 and the outlet hole 14. The air guide plate 26 may be formed to channel air

from the inlet hole 12 and out through the outlet hole 14. The air guide plate 26 may also channel air from the inlet hole 12, over the cylindrical outer surface 98 of the shaft 22, and into the plurality of rotor fins 24. Optionally, air from the inlet hole flows adjacent to the downstream side 48 of the bearing seal 84.

[0019] Cooling air may enter the motor housing 10 through the inlet hole 12, flow adjacent to the bearing seal 84, and then flow along the outer surface 98 of the shaft 22. This air may then be drawn into the rotor 20, where the rotor fins 24 may act like a centrifugal blower and cause the air to exit radially outward through the outlet hole 14. The air guide plate 26 may act to separate the inlet air from the outlet air and to shield the bearing 94 from excess heat.

[0020] With continuing reference to Figure 1, the motor housing 10 may include a plurality of inlet holes 12, a plurality of outlet holes 14, and a plurality of air guide plates 26. The plurality of inlet holes 12 may be situated in the same radial plane 18. Likewise, the plurality of outlet holes 14 may be situated in the same radial plane 18. Optionally, the plurality of inlet holes 12 may be situated in the same radial plane 18 as the plurality of outlet holes 14. Further cooling may be conducted in which the cooling air enters (for example, radially inward) through the plurality of inlet holes 12, guided by the plurality of air guide plates 26 to flow adjacent to the bearing seal 84, and then flow along the outer surface 98 of the shaft 22. This air may then be drawn into the rotor 20, where the rotor fins 24 may act like a centrifugal blower and cause the air to exit radially outward through the plurality of outlet holes 14. The plurality of air guide plates 26 may serve to effectively shield the bearings 94 form excess heat.

[0021] In Figure 2, the exterior of the motor housing 10 shows an arrangement of the plurality of inlet holes 12 and the plurality of outlet holes 14. The inlet holes 12 and the outlet holes 14 may alternate. For example, each outlet hole 14 may be located in between two through inlet holes 12.

[0022] Returning to Figure 1, a method for cooling the motor 10 within the motor housing 72 may include providing the motor housing 72 with an axis 16.

A through inlet hole 12 and a through outlet hole 14 may be provided in the motor housing 72. The method may continue with providing the rotor 20 on the shaft 22, with the shaft 22 optionally being coaxial with the motor housing 72. Next, air may be directed radially inward through the through inlet hole 12, into the motor housing 72, into a rotor 22, and radially outward through the through outlet hole 14. The method may include using the through inlet hole 12 and the through outlet hole 14 in the same radial plane 18. The radial plane 18 may be perpendicular to the axis 16 of the motor housing 72.

[0023] Air may be directed radially inward through a plurality of through inlet holes 12 in the motor housing, and radially outward through a plurality of through outlet holes 14 in the motor housing 72. During this method, air may be directed over the outer surface 98 of the shaft 22 before the air is directed into the rotor 20. Also, air may be directed over the surface 98 of the shaft 22 before accelerating air radially outward through the through outlet hole 14.

[0024] Although the present invention has been described in considerable detail with reference to certain preferred versions thereof, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained therein.